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H4P
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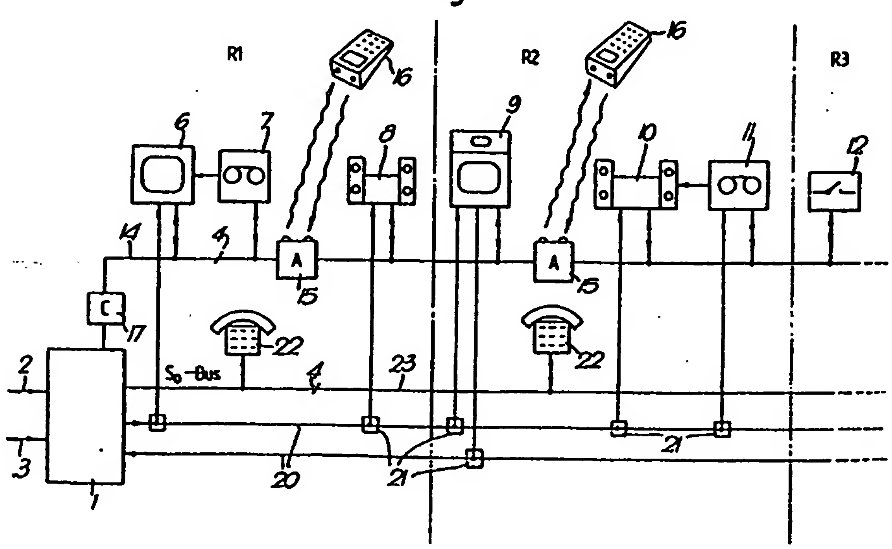
(54) In-house distribution facility for a broadband communication system

(57) An in-house distribution facility has an interface unit (1) which provides a connection to the broadband communication network (2, 3). Between the interface unit (1) and the subscriber terminals (6, ..., 11), e.g., television sets, video recorders, stereophonic radio receivers, video and audio signals are transmitted over a broadband line (20).

The interface unit (1) is connected to the subscriber terminals by means of an in-house communication bus (14) to which central remote control units (16) provided in the various rooms are connected via one bus adapter (15) each. The communication bus (14) has a control circuit (17) which controls the communication on this bus so that collisions are avoided. The remote control units (16) can also control subscriber terminals located in other rooms and interrogate them for their status. Moreover, signalling data for channel selection can be transmitted to the communication network. Evaluation of reflected control signals is avoided.

Fig. 1.



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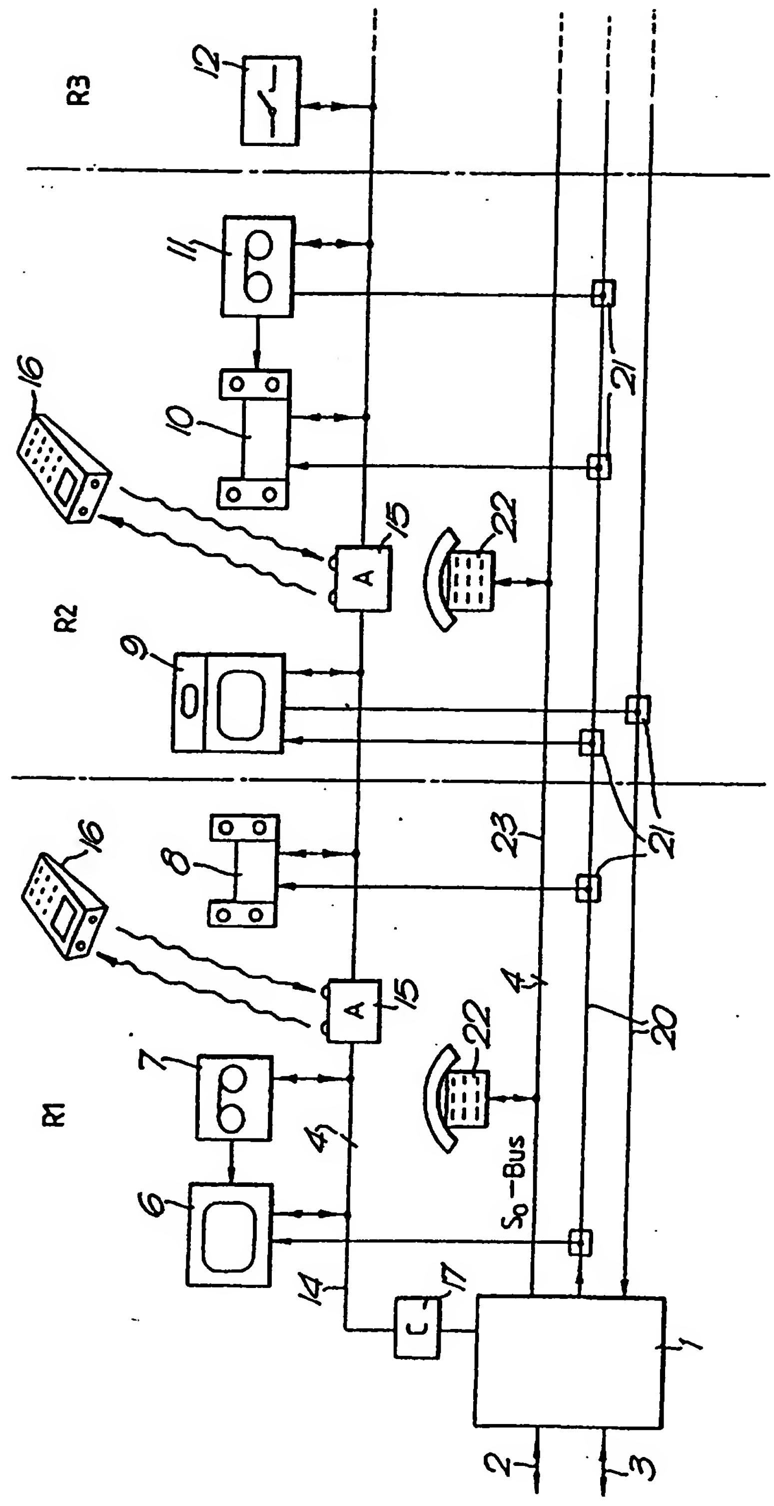


Fig. 1.

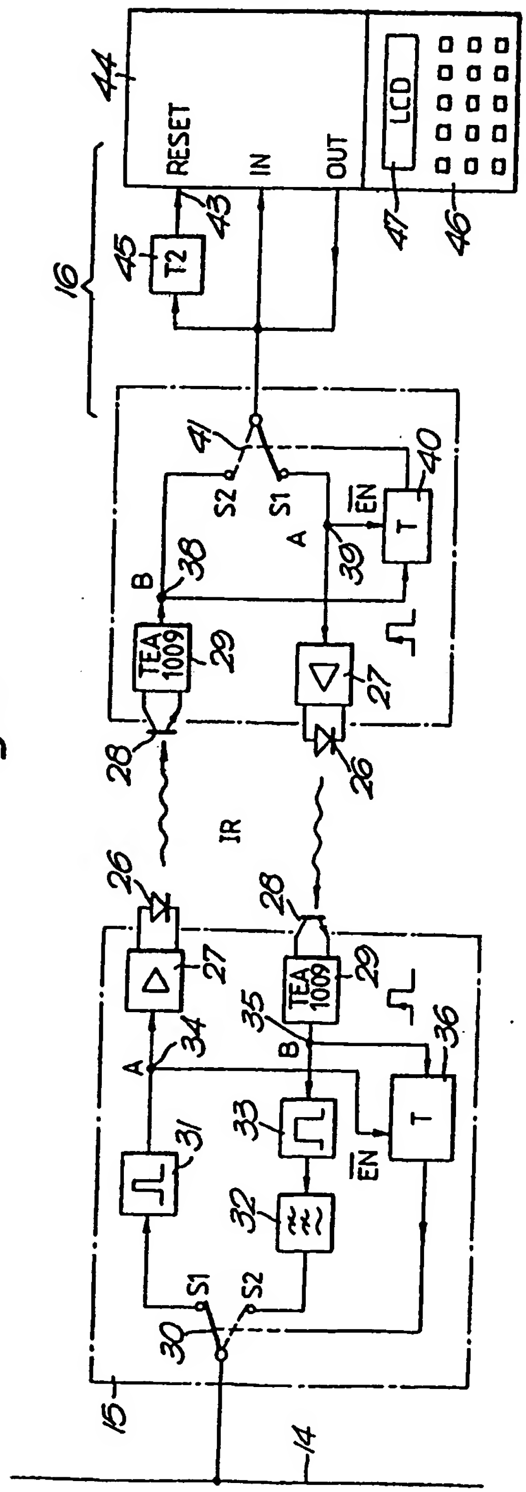

44
RESET
IN
OUT
LCD
47
46
43
45
T2
16
41
S2
S1
40
EN
T
A
39
B
38
TEA 1009
29
27
28
26
IR
26
27
28
29
TEA 1009
A
34
35
B
36
31
33
T
EN
32
S1
S2
30
15
14

Fig.2.

Fig.3.

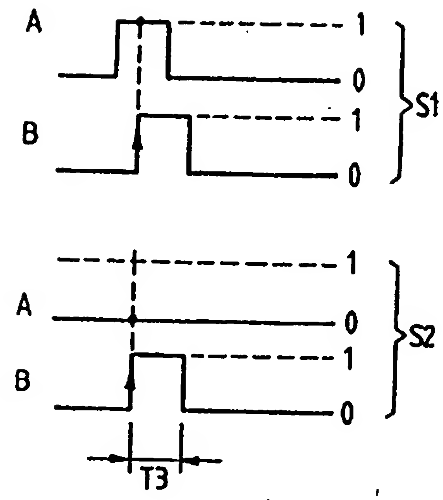
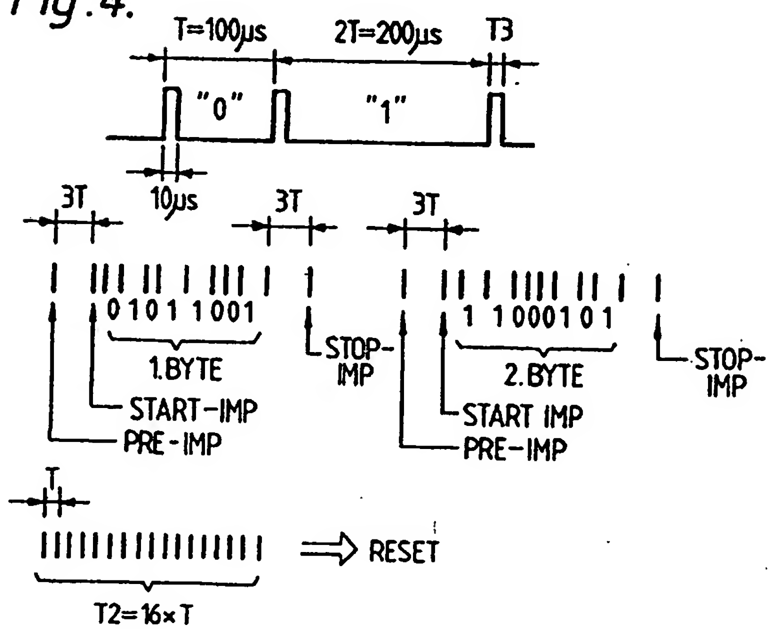

A
1
0
S1
B
1
0
1
A
0
S2
B
1
0
T3

Fig.4.


T=100µs
2T=200µs
T3
"0"
"1"
3T
10µs
3T
3T
0 1 0 1 1 0 0 1
1.BYTE
START-IMP
PRE-IMP
STOP-IMP
1 1 0 0 0 1 0 1
2.BYTE
START IMP
PRE-IMP
STOP-IMP
T
RESET
T2=16×T

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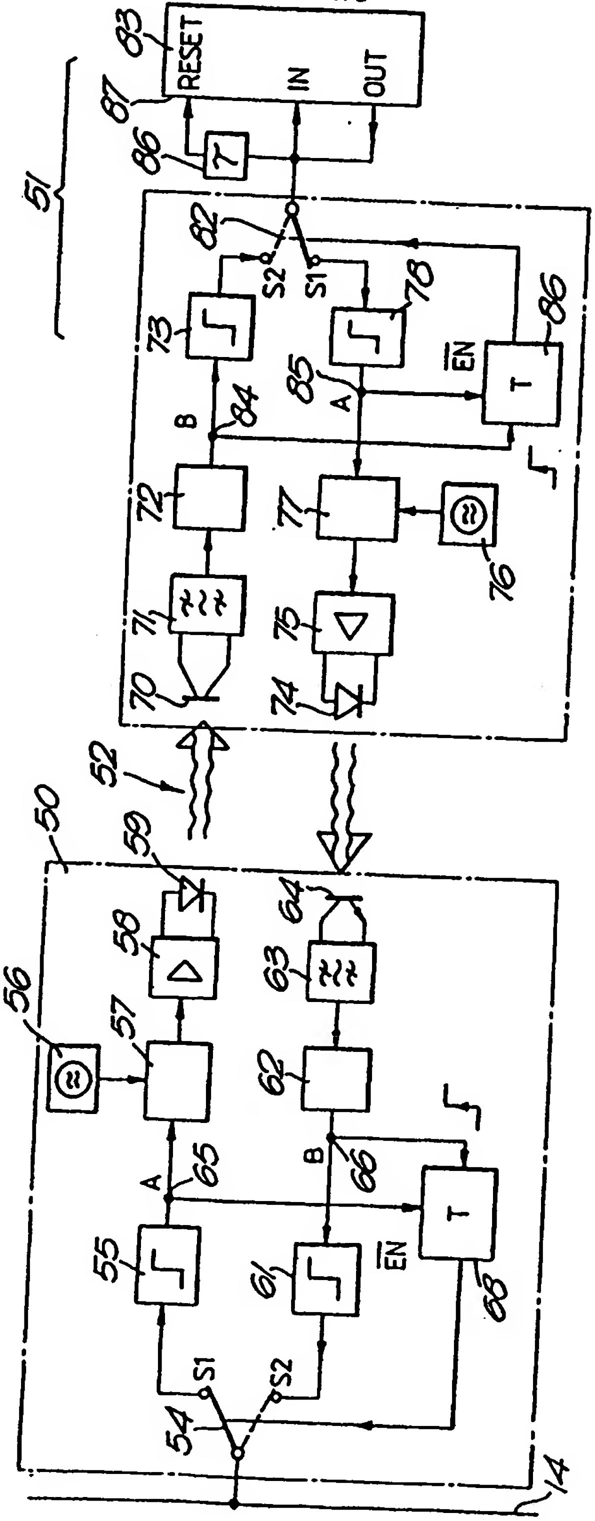


Fig. 5.

Fig.6.

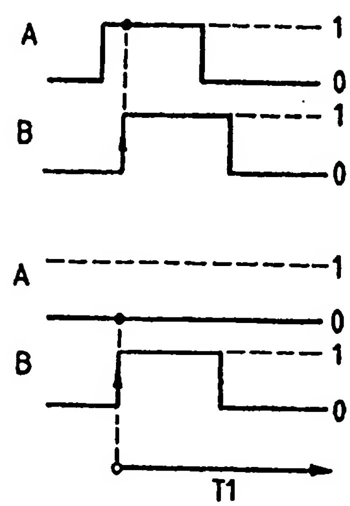
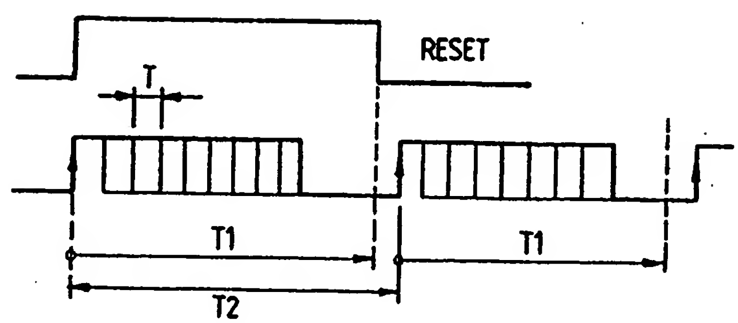


Fig.7.



SPECIFICATION

In-house distribution facility for a broadband communication system

The present invention relates to an in-house distribution facility for a broadband communication system having an interface unit which provides the connection to the broadband communications network.

In the field of narrowband communication services (telephony, data and text transmission, facsimile, etc.), the desire for creation of a public ISDN network encompassing all of these services has already resulted in far-reaching proposed international standards by the CCITT.In the case of broadband communication services (transmission of television, video-telephone and stereophonic sound signals via the public network), the BIGFON field test conducted by Deutsche Bundespost has already led to the development of several operable systems (ntz, Vol. 36 (1983), No.7, pp. 428 - 433).

An in-house distribution facility is described in European Patent No. 0,024,618. With this facility, both broadband and narrowband signals are distributed to various entertainment electronics devices at a subscriber location, in particular to radio and television receivers. The signals to be distributed are transmitted on a coaxial line, which is connected with a separating filter in which the two directions of transmission channels are separated.

The subscriber selects the desired program by means of control signals, which are transmitted in a wireless manner from a remote control unit to a so-called backward channel facility, where they are then converted into digital signal words for transmission to an interface unit in a backward channel, assigned to the respective subscriber terminal, on the coaxial line; from the interface unit they are then transmitted to the public switching exchange. Mention is also made of the fact that the control signals can also be transmitted to the interface unit from the receiver's individual backward channel facilities via a multiplex line, provided in addition to the coaxial line. However the patent does not provide any recitations regarding how this multiplex line could, in fact, be implemented and function. With the prior-art in-house distribution facility, it is not possible for a remote control unit to control any other subscriber terminal than that to which it is associated.In particular, it is not possible to control terminals that are located in a different room from the subscriber or to query their status.

The present invention seeks to provide an in-house distribution facility for integrated broadband and narrowband services which permits data and control signals to be transmitted within the building, i.e. between subscriber terminals and other terminals located in various rooms.

According to the invention there is provided an in-house distribution facility for a broadband communication system, having an interface unit which provides the connection to the broadband communication network, having a broadband line for transmitting video and audio signals between the interface unit and the subscriber terminals, having a signalling line which connects the interface unit with the subscriber terminals, and having remote control devices for controlling subscriber terminals characterised in that the interface unit is connected to the subscriber terminals by means of an in-house communication bus, remote control units are connected to the communication bus via a bus adapter, and the communication bus contains a control circuit which controls the communication on the communication bus in such a manner as to avoid collisions.

In order that the invention and its various other preferred features may be understood more easily, some embodiments thereof will now be described, by way of example only, with reference to the drawings, in which:-

Figure 1 is a block schematic diagram of an in-house distribution facility constructed in accordance with the invention.,

Figure 2 is a block schematic diagram of a remote control system for the distribution facility of Figure 1,

Figure 3 is a waveform diagram showing the signal waveforms at two locations in the remote control system of figure 2,

Figure 4 is a signal modulation diagram for the remote control system of Figure 2,

Figure 5 is a block schematic diagram of an alternative remote control system for the distribution facility of Figure 1,

Figure 6 is a waveform diagram showing the signal waveforms at two locations in the remote control system of Figure 5, and

Figure 7 is a signal modulation diagram showing waveforms employed in the remote control system of Figure 5.

The in-house distribution facility of Figure 1 has an interface unit 1, which represents the connection between an in-house distribution facility and a broadband communication network.

Only a connection line 2 of the broadband ISDN network is shown here, being designed, for example, in the form of an optical waveguide and permitting bidirectional communication at a bit rate of 280 Mb/s, for example. Moreover, a two-conductor connection line 3 to the narrowband ISDN network is also illustrated, on which bidirectional communication is also possible.

The subscriber's building or home has various rooms or offices R1, R2, R3, etc., which are merely suggested here, with one or more subscriber terminals connected to the in-house distribution facility being located in each room or office: A first television set 6, a video recorder 7, a stereophonic radio receiver 8, a video-telephone set 9, a second radio receiver 10 and a second video recorder 11. So-called building services - e.g. a door opener, a heating system, etc., which can be remote controlled by means of the in-house distribution facility of the present invention - are suggested by means of a switch 12 in room R3.

An in-house communiction bus 14 connects interface unit 1 with individual subscriber terminals 6 to 11, with building services 12, as well as with bus

adapters 15, which are employed for connecting central remote control units 16 to communication bus 14, and thus to the in-house distribution facility.Data is transmitted between remote control unit 16 and bus adapter 15 by means of infrared light. Since this communication is bidirectional, both bus adapter 15 as well as central remote control unit 16 each has an IR sender and an IR receiver. Further explanation of the remote control unit is provided later in this description. Communication bus 14 has a control circuit 17 which controls the communication on this bus in such manner that collisions are avoided.

Interface unit 1 is connected with subscriber terminals 6 to 11, or at least with a portion thereof, by means of a broadband line 20 -formed by a coaxial cable and illustrated in the drawing by means of two individual conductors.The television, radio and stereophonic sound signals are transmitted on broadband line 20 at a rate of 280 Mb/s in the downstream direction, i.e. from the interface unit to the subscriber terminals. In the upstream direction - i.e. from the subscriber terminals to the interface unit, and from there to the network - the signals are transmitted at a rate of 70 Mb/s, if video-telephone service is to be provided. Subscriber terminals 6 to 11 are connected to broadband line 20 via passive broadband boxes 21.

Interface unit 1 is connected with telephone sets 22 contained in the individual rooms by means of a four-conductor narrowband bus 23, which corresponds to the $S_o$bus in the ISDN standard. The communication bus also has four individual conductors: Ground, supply voltage and two conductors for symmetrical signal transmission. Only one signal conductor is required in the case of asymmetrical transmission. The supply conductor and the ground conductor permit electrical current to be provided to bus adapters 15 and to optical couplers, which provide electrical isolation in the inputs of subscriber terminals 6 to 12.

The remote control system shown in Figure 2 for the in-house distribution facility has two sections: Central remote control unit 16 and bus adapter 15 associated thereto.As opposed to conventional remote control systems, in which control signals are transmitted only from the remote control transmitter to the device to be controlled, it is necessary here for remote control unit 16 to also receive data, e.g. in conjunction with querying the status of the subscriber terminals and the building services. In addition, signals are also transmitted in both directions in conjunction with the control process, itself. Consequently, both remote control unit 16, as well as bus adapter 15, have a send diode 26 with an infrared send circuit 27, as well as a phototransistor 28 with an infrared receive circuit 29, serving as the receiver. The send circuit and the receive circuit are available in the marketplace in the form of integrated circuits (ICs).

Bus adapter 15 has a switch 30, via which either its send branch (position S1) or its receive branch (position S2) is connected with communication bus 14. In the send branch, it has a pulse shaper 31, and in the receive branch a low-pass filter 32, as well as a pulse shaper 33. Signals tapped at a point 34 in the send branch and at a point 35 in the receive branch are advanced to a timing element 36. Timing element 36 controls switch 30, in accordance with the signal waveforms shown in Figure 3. In the event that a transmitted pulse is reflected, a pulse B occurs at point 34, with pulse B being delayed relative to pusle A at point 34 primarily as a result of the propagation delay in send circuit 27 and in receive circuit 29. In the practical example, the delay period is less than 10 microseconds. Switch 30 then remains in position S1, and received pulse B is not advanced. If, on the contrary, the delay is greater than or equal to pulse length T3, pulse B is a signal pulse received length T_3, pulse B is a signal pulse received from remote control unit 16, causing switch 30 to move to its position S2, with a make time of approx. T, and the signal pulse is advanced.

Similarly, the signals tapped at a point 38 in the receive branch and at a point 39 in the send branch of remote control unit 16 are advanced to a timing element 40, which switches a switch 41 between two positions S1 and S2. Consequently, send pulses reflected in remote control unit 16 are not advanced either, thereby preventing faulty control.

Arranged between switch 41 is a counting input 43 of a microprocessor 44 is a counting circuit 45. This counting circuit identifies arrival of a specific reset signal, with which control circuit 17 (Figure 1) can, if necessary, reset any of the terminals connected to communication bus 14. It is necessary for this reset signal to be able to be clearly differentiated from the other signals transmitted via bus 14 or the infrared links. It can comprise, for example, at least ten successive zeroes; however it must not, in any event, be an ASCII character. When a signal of this nature arrives, counting circuit 45 provides an appropriate signal to reset input 43 of microprocessor 44.

The microprocessor analyses the commands entered by means of a keyboard 46 of central remote control unit 16 and generates appropriate infrared signals via send diode 26, which are then transmitted to bus adapter 15, from where they are advanced to the respective receiver via communication bus 14. On the other hand, microprocessor 44 also analyses the incoming signals arriving via the infrared link, which signal to the operator, for example, the status of a subscriber terminal located in another room. Microprocessor 44 has an LCD display 47, which affords comfortable user guidance.

In order to be able to interrogate individual subscriber terminals, e.g. tape decks or video recorders, for their status, the IR transmission link is equipped for two-way transmission; however a half-duplex mode is sufficient for this purpose, i.e. it is not necessary to be able to send and receive simultaneously. If the signal code used on the IR link is also employed as the line code on communication bus 14, it is not necessary for code conversion to be performed in bus adapters 15. Consequently, the circuitry sophistication required

for bus adapter 15 is especially minor; in particular, no so-called intelligence is required.

Because of its range and low susceptibility to interference, the known pulse spacing code (Brochures SAA 1250 and SAA 1251 from the Intermetall company) is very well suited for the infrared link between bus adapter 15 and remote control transmitter 16. This code is shown schematically in Figure 4. The binary information of a bit is contained in the time interval between two pulses. A short interval of time T = 100 µ represents binary "zero", while a long interval 2T represents binary "one". In addition, each data telegram is also provided with a prepulse and a start pulse, separated by an interval of 3T, as well as a stop pulse, separated by an interval of 3T from the last data bit. The prepulse is employed as a reference pulse for controlling amplification in the IR receive amplifier. This is asynchronous, serial data transmission. As in the case of the standard V24 interface, the start pulse also serves as a time reference for counting the subsequent data pulses.

Since the pulses only have a width of approx. 10 µs, a peak current of 3 A, for example, can be selected, which produces a good signal-to-noise ratio, while permitting the average battery current to remain within limits. Since central remote control transmitter 16 is battery-powered, low power consumption is an important aspect.

Before being fed into communication bus 14, the signal pulses are lengthened to 50 µs, for example, in bus adapter 15 and then shortened to 10 µs again prior to IR conversion. This permits the spectral centroid to be shifted to lower frequencies, so that high-frequency interference received in the line can be reduced by means of receive-side band limitation.

The alternative remote control system shown in Figure 5 also has a bus adapter 50 connected with communication bus 14 and a remote control unit 51. The infrared link 52 that connects them is suggested in the drawing. A switch 54 connects communication bus 14 with either the send branch (position S1) or with the receive branch (position S2) of the bus adapter. Contained in the send branch is a threshold switch 55, a modulator 57 connected with a frequency generator 56, a send amplifier 58 and an IR send diode 59. Contained in the receive branch are a threshold switch 61, a demodulator 62, a bandpass filter 63 and a receive diode or a phototransistor 64.

Signals are tapped at a point 65 in the send branch and at a point 66 in the receive branch and advanced to a timing element 68, which controls switch 54. The position S1 for the switch is shown in Figure 6. Switch 54 is located in position S2 if signal A is "zero" at point 65 when the leading edge of a signal B appears at point 66. Otherwise, the switch remains in position S1, as signal B represents a reflected pulse. The switch make time must be greater than or equal to the duration of the longest character to be transmitted, i.e. the reset character.

Located in the receive branch of remote control transmitter 51 are a phototransistor 70, a bandpass filter 71, a demodulator 72 and a threshold switch 73. The send path includes: A send diode 74, a send amplifier 75, a modulator 77 connected with a frequency generator 76, and a threshold switch 78. A switch 82 alternately connects the two branches with a microprocessor 83.

Signals B and A, respectively, are tapped at a point 84 in the receive branch and a point 85 in the send branch and are advanced to a time analysis circuit 86, which controls switch 82 in accordance with the condition shown in Figure 6. The design of the circuitry in bus adapter 50 and remote control unit 51 is, for the most part, identical, with remote control unit 51 only additionally including microprocessor 83 and counting circuit 86.

In addition to a signal input and output, which can be seen from the drawing, microprocessor 83 also has a reset input 87, which is connected with the output of counting circuit 86. Should counting circuit 86 identify a reset command, it resets microprocessor 83 to its initial position. T_1 represents the reset time in Figure 7 with the reset condition being $T_1 = 9 \times T$. T_2 is the time between two successive characters.

In the practical example according to Figure 5, as well, transmission is performed asynchronously, with start and stop bits; however an NRZ (non return to zero) code is employed. The signal pulses are significantly longer than in the case of the practical example according to Figure 2. A schematic representation of a character transmitted in a code of this nature, e.g. an ASCII character, can be seen from Figure 7. If the base time for one bit in this code is T, time T_2 between arrival of two successive messages is greater than or equal to 12×T. Shown in the uppermost line of Figure 7 is a reset pulse, whose length here is $T_w = 11 \times T$, thereby providing clear differentiation between it and an ASCII character.

The signal pulses are chopped with a modulation frequency of 60 to 100 kHz, for example, for transmission. Steady-light interference, 100 Hz hum interference and other noises are suppressed by means of selective receiving. As already mentioned, the input channel is interlocked against reflected output signals. Here, too, a reset signal is identified by counting the signal pulses in counting circuit 86. A reset signal of this nature is transmitted by control circuit 17 of communication bus 14 if remote control unit 16 - or another microprocessor-controlled terminal connected to the communication bus - does not respond properly to repeatedly transmitted control commands.

The signalling message transmitted to interface unit 1 is re-encoded in accordance with the ISDN-D protocol.

In the case of every asynchronous transmission system, it is possible for bus collisions to occur if, for example, two terminals wish to transmit data at the same time. It is the task of control circuit 17 to prevent these collisions. Each of terminals 6 to 12 connected to communication bus 14 which are able to send or receive data is assigned an address. In addition, the central remote control units, of which one can be present in each room R1, R2,

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..., as well as control circuit 17, also have addresses. Only bus adapters 15, via which the IR transmission links are connected to communication bus 14, do not have addresses. Data communication via the bus is controlled by means of address polling, with acknowledgement. Control circuit 17 sequentially addresses all devices 6 to 12 and 16. If one of these devices wishes to transmit data, it transmits a service request after having received its address. It then receives a request to send from the control circuit. It can now transmit its data telegram. The telegram consists of - Its own address (source) - The destination address (drain) - One or more data - A check word - An end-of-telegram character. The device with the destination address (drain) only sends an acknowledge signal to the source if the check word is correct.Otherwise, it remains silent. Should the data source not identify an acknowledge signal, it again transmits a service request (SRQ) for the purpose of repeating a telegram.

An acknowledgement mode of this nature is beneficial with respect to the infrared transmission link, in particular, as it is possible for this link to be interrupted as a result of obstructions.

Control circuit 17 is addressed as the destination address for upstream signalling, i.e. signalling to the communication network, for the purpose of channel selection. In this case, the sending device is either a subscriber terminal 6 to 12, which received the channel request previously by means of normal remote control, or a central remote control unit 16.

Another possibility for arbitrating communication bus 14 is for control circuit 17 to transmit synchronising pulses - having a duration of 128 μs, for example - at cyclical intervals of 1.4 ms, for example. The individual subscriber terminals 6 to 12 and central remote control transmitters 16 are assigned specific time slots which are determined by fixed time intervals following the respective preceding synchronising pulse.Any terminal 6, 7, ..., 11 or remote control unit 16 can cut in on communication bus 14 during its assigned time slot and commence a transmission, unless another terminal has commenced its transmission during the period of time between the synchronising pulse and its own time slot. Time slots for thirty-two different subscriber terminals are provided between two successive synchronising pulses, for example.

The start bit sent by a subscriber terminal at the beginning of a data telegram has a length of 256 μs, for example, thereby permitting it to be easily differentiated from the synchronising pulses. A message telegram comprises at least three bytes: Destination address, source address, and one or more data bytes. The sunchronising pulses are not transmitted by control circuit 17 during signalling. The control circuit recognises the end of a telegram, e.g. by the absence of the next start bit. It then resumes sending the periodic synchronising pulses.

With this method of bus arbitration, as well, contention for possession of the bus is also effectively prevented.In particular, this method of bus arbitration offers the advantage of a shorter time of access - 1.4 ms, for example - to free communication bus 14.

CLAIMS

1. An in-house distribution facility for a broadband communication system, having an interface unit which provides the connection to the broadband communication network, having a broadband line for transmitting video and audio signals between the interface unit and the subscriber terminals, having a signalling line which connects the interface unit with the subscriber terminals, and having remote control devices for controlling subscriber terminals, characterised in that the interface unit (1) is connected to the subscriber terminals (6 to 11) by means of an in-house communication bus (14), remote control units (16) are connecled to the communication bus (14) contains a control circuit (17) which controls the communication on the communication bus (14) in such a manner as to avoid collisions.

2. An in-house distribution facility as claimed in claim 1, characterised in that the interface unit (1) is connected with subscriber telephone sets (22) by means of a narrowband ISDN bus (23).

3. An in-house distribution facility as claimed in claim 1 or 2, characterised in that the devices (6, 7, ..., 12) connected to the communication bus (14) are assigned addresses via which they can be sequentially polled by the control circuit (17) until the latter receives a service request signal through which a polled device signals that a message is ready to be transmitted, and in that, upon receipt of a service request, the control circuit (17) sends a request signal to this terminal (6, 7, ..., 12) through which transmission of the message is enabled.

4. An in-house distribution facility as claimed in claim 3, characterised in that a device (6 to 12, 16, 17) receiving a message reviews this message on the basis of a check word and, if the result of the review is positive, transmits an acknowledge signal to the sending device.

5. An in-house distribution facility as claimed in claim 4, characterised in that the sending device (6, ..., 12, 16, 17) re-sends a service request signal if an acknowledge signal is not received following a transmitted message.

6. An in-house distribution facility as claimed in any one of claims 3 to 5, characterised in that an address is assigned to the control circuit (17), so that signalling data transmitted by any of the terminals (6 to 12) are received by the control circuit (17) and converted for upstream signalling to the broadband network (2, 3).

7. An in-house distribution facility as claimed in any one of the preceding claims, characterised in that the communication bus (14) has ground conductor, a supply conductor, a first signal conductor, and a second signal conductor, which is twisted with the first signal conductor and on which the inverted signal is transmitted.

8. An in-house distribution facility as claimed in any one of the preceding claims, characterised in

that the remote control unit (16) and the bus adapter (15) contain circuits (30, 31) which block the respective receive path for reflected signal pulses.

9. An in-house distribution facility as claimed in any one of the preceding claims, characterised in that the remote control unit (16) includes a microprocessor (44) and a counting circuit (45) connected with the microprocessor (44), and in that the counting circuit (45) identifies reset commands transmitted by the control circuit (17) of the communication bus (14) and causes a signal to be provided to the reset input (43) of the microprocessor (44) when a command of this nature arrives.

10. An in-house distribution facility as claimed in any one of claims 1, 2, 7, 8 or 9, characterised in that data exchange on the communication bus (14) is controlled by synchronising pulses transmitted by the control circuit (17), and in that the subscriber terminals (6 to 12) and the central remote control unit (16) are assigned predetermined time slots which are determined by fixed intervals from the respective preceding synchronising pulse and in which a transmission can be started.

11. An in-house distribution facility for a broadband communication system substantially as described herein with reference to the drawings.

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